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USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK
Volume 117.
F-16A In-Flight Crew Noise,

10 **Herald K. Hille**

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FOR THE COMMANDER



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Director

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The F-16A is a USAF lightweight fighter. This report provides measured data defining the bioacoustic environments at the pilot's location inside this aircraft for 16 flight conditions. Data are reported for one location in a wide variety of physical and psychoacoustic measures: overall and band sound pressure levels, C-weighted and A-weighted sound levels, preferred speech interference level, perceived noise level, and limiting times for		

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total daily exposure of personnel with and without standard Air Force ear protectors. Refer to Volume 1 of this handbook, "USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application," AMRL-TR-75-50(1) 1975, for discussion of the objective and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc.

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Preface

This report was prepared by the Biodynamic Environment Branch, Aerospace Medical Research Laboratory, under Project/Task 723108, Crew Safety In Operational Noise Environments.

The author acknowledges the efforts of John N. Cole, who established the data analysis requirements and assisted in the preparation of this report, and Henry Mohlman and David Eilerman of the University of Dayton, who assisted in the mechanics of data processing.

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INTRODUCTION

The F-16A is a USAF lightweight fighter manufactured by the General Dynamics Company, Fort Worth, Texas. Power is provided by one F100-PW-100(2) turbofan engine manufactured by the United Aircraft Corporation, Pratt & Whitney Aircraft Division.

This volume provides measured data defining the bioacoustic environments produced inside the aircraft. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with operations of the F-16A aircraft.

This volume is one of a series published by the Aerospace Medical Research Laboratory (AMRL) under the same report number (AMRL-TR-75-50) as a multi-volume handbook that quantifies the noise environments produced at flight/ground crew locations and in surrounding communities by operations of Air Force aircraft and ground support equipment. The far-field, community-type, noise data in the handbook describe the noise produced during *ground operations* of aircraft, ground support equipment, and other ground-based equipment or facilities.

Volume 1 of this handbook discusses the objectives and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc. *Refer to Volume 1* (reference 1) for such information because it is not repeated in other handbook volumes.

A cumulative index lists those aerospace systems contained in the handbook, and identifies the specific volumes containing each type of environmental noise data available (i.e., in-flight/flight crew and passenger noise, near-field/ground crew noise, far-field/community noise). Volume numbers are assigned sequentially as individual volumes are published. This index is periodically updated as individual volumes are published, and is available upon request from AMRL/BBE, Wright-Patterson AFB, OH 45433. Organizations on the distribution list for the handbook will automatically receive a copy of the updated index as it is generated.

Direct any questions concerning the technical data in this report and other handbook volumes to: AMRL/BBE, Wright-Patterson AFB, OH 45433; Autovon 78-53675 or 78-53664; Commercial (513) 255-3675 or (513) 255-3664.

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1. Cole, John N., *USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application*, AMRL-TR-75-50 (1), Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1975.

IN-FLIGHT NOISE

MEASUREMENTS

All noise measurements were made on-board a F-16A aircraft during typical speed, altitude, and flight maneuver conditions. These levels describe the standard F-16A environments but may not be representative of those levels encountered if the aircraft has been configured differently (e.g., major equipment or structural changes).

Acoustic measurements were made inside the cockpit at the pilot's location. Table 1 lists the measurement location and test conditions as numeric/alphabetic designators which are used on the data pages. The designator 1/A means measurement location 1 and test condition A, etc.

The microphone was attached to the pilot's helmet by means of a lightweight boom. This arrangement enabled adjustment of the microphone close to the ear level at a distance of 0.1 meter with its diaphragm parallel and facing away from the helmet's surface. In the analysis, microphone corrections for random incidence were applied to the overall systems response. The recorded samples were analyzed using a four or eight second integration time to obtain a power-averaged level which effectively smooths out short duration fluctuations and best describes the exposure.

RESULTS

The measured data presented in Table 2 define the sound pressure levels (SPL) produced inside the F-16A aircraft at the specified location. This table includes the overall, 1/3 octave band, and octave band levels. From these data, C-weighted and A-weighted sound levels, maximum permissible time for one exposure per day (AFR 161-35) with and without standard Air Force ear protectors, preferred speech interference level, and perceived noise level are calculated and presented in Table 3. These measures are widely used to assess the effects of noise on personnel and their performance.

TABLE 1
MEASUREMENT LOCATIONS AND TEST CONDITIONS
F-16A, Edwards AFB, 27 May 1977
Serial #75-0745

<i>Location</i>	<i>Position</i>	<i>Flight Above Deck</i>
1	Cockpit	Seated Head Level

<i>Condition</i>	<i>Description</i>
A	Idle Power, Canopy Closed, Air Source — NORM, Temp — AUTO (mid), Defog — DECR
B	Mil Power Takeoff, Air Source — NORM, Temp — AUTO (mid), Defog — DECR
C	Mil Power, Climb to 5000 Ft, Air Source — NORM, Temp — AUTO (mid), Defog — DECR
D	Mil Power, Climb from 15000 Ft to 30000 Ft, Speed 410 KIAS, .8 M, —304 KIAS, .8 M, Air Source — NORM, Temp — AUTO (mid), Defog — FWD
E	Cruise at 25000 Ft, Speed 338 KIAS, .8 M, Air Source — NORM, Temp — AUTO (mid), Defog — FWD
F	Cruise at 20000 Ft, Speed 373 KIAS, .8 M, Air Source — NORM, Temp — AUTO (mid) and Defog — FWD
G	Cruise at 20000 Ft, Speed 373 KIAS, .8 M, Air Source — NORM, Temp — MAN, Defog — FWD
H	Cruise at 20000 Ft, Speed 373 KIAS, .8 M, Air Source — NORM, Temp — AUTO (mid) and Defog — MAX
I	Cruise at 20000 Ft, Speed 373 KIAS, .8 M, Air Source — OFF
J	Normal Descent from 20000 Ft to 5000 Ft, Idle, S/B Out, Air Source — NORM, Temp — AUTO (mid), Defog — FWD
K	Cruise at 5000 Ft, Speed 488 KIAS, .8 M, Air Source — NORM, Temp — AUTO (mid), Defog — FWD
L	Cruise at 5000 Ft, Speed 488 KIAS, .8 M, Air Source — NORM, Temp — MAN, Defog — FWD
M	Cruise at 5000 Ft, Speed 488 KIAS, .8 M, Air source — NORM, Temp — AUTO (mid), Defog — MAX
N	Cruise at 5000 Ft, Speed 488 KIAS, .8 M, Air Source — OFF
P	High Speed Run at 10000 Ft, Speed from 448 KIAS, .8 M to 637 KIAS, 1.12 M, Air Source — NORM, Temp — AUTO (mid), Defog — OFF
Q	Landing and Roll, Air Source — NORM, Temp — AUTO (mid), Defog — FWD

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)										IDENTIFICATIONS:	
1/3 OCTAVE BAND											
2										OMEGA 3.2	
NOISE SOURCE/SUBJECT:										TEST 77-009-001	
(OPERATION:										RUN 01	
(
(F-16A AIRCRAFT										27 SEP 78	
(INFLIGHT NOISE LEVELS											
(PAGE F1	
FREQ (HZ)	1/A	1/B	1/C	1/D	1/E	1/F	1/G	1/H	1/I		
31.5	77	84	84	70	69	71	83	74	57		
40	80	88	83	72	71	72	80	73	58		
50	80	85	81	69	69	69	75	73	62		
63	81	85	87	80	80	81	84	77	69		
80	81	84	85	78	78	81	85	75	68		
100	83	87	89	84	85	85	86	80	73		
125	87	89	91	86	87	86	90	84	80		
160	82	86	89	84	86	83	88	86	84		
200	91	90	95	91	91	93	91	85	77		
250	92	93	97	94	93	95	96	90	86		
315	89	89	93	89	91	91	93	89	83		
400	93	93	99	92	93	93	97	88	85		
500	91	95	94	92	93	94	98	89	82		
630	92	95	96	93	93	94	99	89	81		
800	92	93	96	94	91	94	98	92	84		
1000	91	92	94	91	91	92	98	90	79		
1250	92	91	96	93	92	93	100	92	78		
1600	85	88	90	87	88	88	97	93	76		
2000	79	83	86	83	84	85	94	93	75		
2500	83	80	81	80	79	79	90	95	72		
3150	81	76	79	78	79	77	86	98	71		
4000	75	72	76	78	78	76	84	99	69		
5000	76	71	78	77	78	76	85	101	70		
6300	73	68	74	78	78	76	79	98	70		
8000	73	67	76	80	80	79	81	98	74		
10000	68	67	76	83	82	81	84	98	74		
12500	64	64	75	82	82	83	89	98	75		
OVERALL	102	103	106	102	102	103	108	108	93		

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)										IDENTIFICATION:	
1/3 OCTAVE BAND											
2										OMEGA	3.2
NOISE SOURCE/SUBJECT:										TEST 77-009-001	
(OPERATION:										RUN 02	
(
F-16A AIRCRAFT											
(
INFLIGHT NOISE LEVELS										27 SEP 70	
(
(PAGE F2	

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)										IDENTIFICATION:
2										
OCTAVE BAND										
NOISE SOURCE/SUBJECT:										OMEGA 3.2
(OPERATION:										TEST 77-009-001
(RUN 01
(F-16A AIRCRAFT										
(INFLIGHT NOISE LEVELS										27 SEP 78
(
(PAGE J1
FREQ										
(HZ)										
31.5										
63										
125										
250										
500										
1000										
2000										
4000										
8000										
OVERALL										
1/A	1/B	1/C	1/D	1/E	1/F	1/G	1/H	1/I		
82	89	86	74	73	74	84	77	61		
85	90	90	82	82	84	86	80	72		
89	92	94	89	91	90	93	89	86		
95	96	100	97	96	98	99	93	88		
97	99	101	97	98	98	103	93	88		
96	97	100	97	96	98	103	96	86		
87	89	92	89	90	90	99	98	79		
83	78	83	82	83	81	90	104	74		
76	72	80	85	85	84	86	103	78		
102	103	106	102	102	103	108	108	93		

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)										IDENTIFICATION:	
OCTAVE BAND											
2										OMEGA 3.2	
										TEST 77-009-001	
										RUN 02	
										27 SEP 78	
										PAGE J2	
NOISE SOURCE/SUBJECT: (OPERATION:)											
F-16A AIRCRAFT ()											
INFLIGHT NOISE LEVELS ()											
()											
1/J 1/K 1/L 1/M 1/N 1/P 1/Q											
FREQ (HZ)											
31.5										84	
63										89	
125										92	
250										98	
500										98	
1000										96	
2000										89	
4000										82	
8000										73	
OVERALL										103	

TABLE: MEASURES OF HUMAN NOISE EXPOSURE											IDENTIFICATION:
3											OMEGA 3.2
NOISE SOURCE/SUBJECT:	OPERATION:										TEST 77-009-001
											RUN 01
F-16A AIRCRAFT											27 SEP 78
INFLIGHT NOISE LEVELS											PAGE M1
		1/A	1/B	1/C	1/D	1/E	1/F	1/G	1/H	1/I	
HAZARD/PROTECTION											
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DB) AT EAR											
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DB) AT EAR											
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)											
NO PROTECTION											
OASLC		102	103	106	102	102	103	108	107	93	
OASLA		99	100	103	100	100	101	106	100	90	
T		36	30	10	30	30	25	11	8	170	
MGU-2A/P HELMET WITH H-154											
OASLA*		88	89	93	89	89	90	93	95	81	
T		240	202	101	202	202	170	101	71	007	
MGU-2A/P HELMET WITH H-154(A)											
OASLA*		84	85	89	85	85	86	89	83	77	
T		480	404	202	404	404	339	202	571	960	
MGU-2A/P HELMET WITH CUSTOM LINER											
OASLA*		95	97	99	96	96	97	102	94	86	
T		71	50	36	60	60	50	21	85	339	
COMMUNICATION											
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)											
PSIL		93	95	98	94	94	95	102	96	84	
ANNOYANCE											
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)											
TONE CORRECTION (C IN DB)											
PNLT		111	111	115	112	111	112	118	123	103	
C		1	1	1	1	0	1	1	1	1	

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

